FAME TELESCOPE
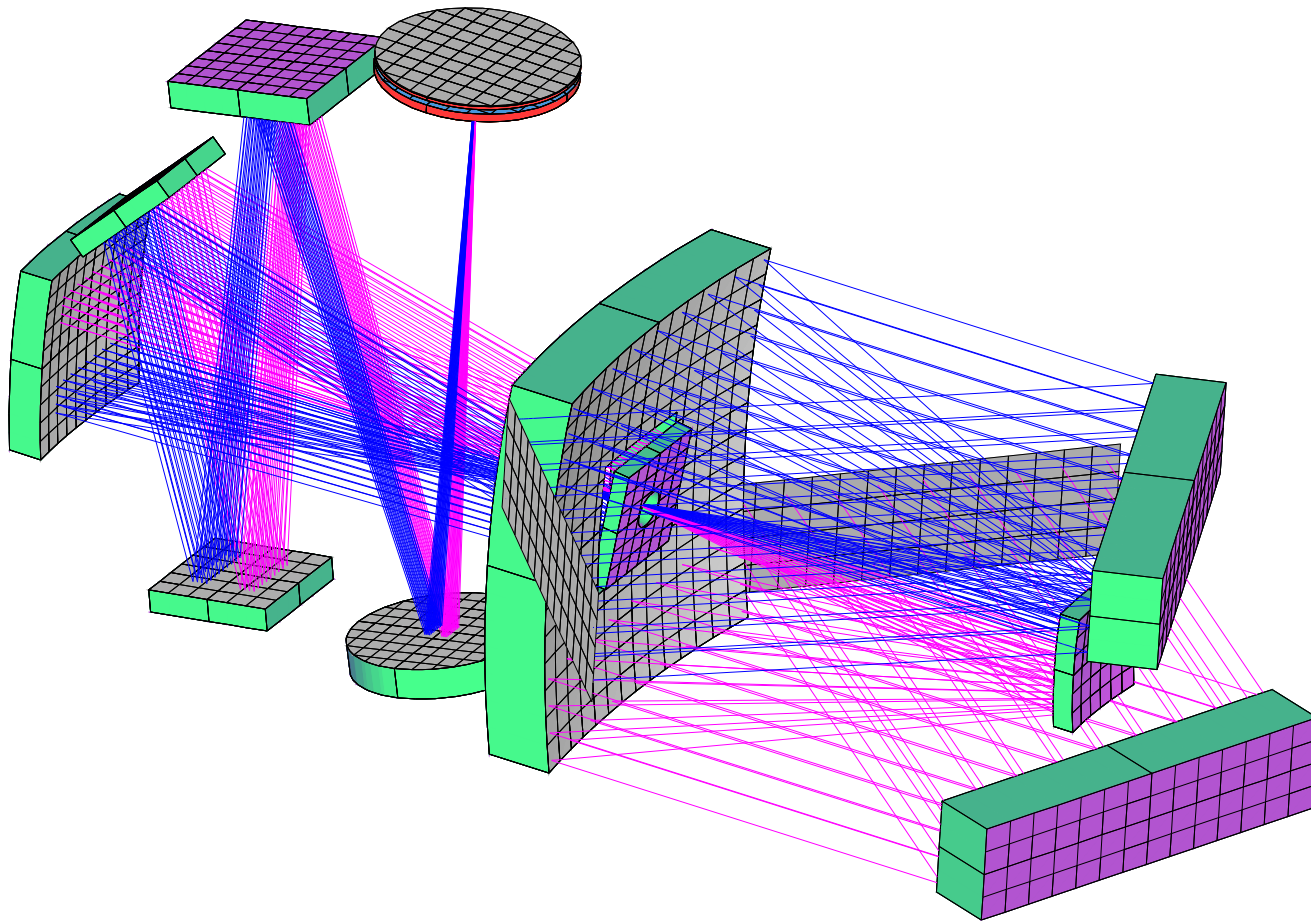
stb 1/17/01 84.3 deg, CM now moved a total of 4 CM out-mirrors

Alpha	Beta	Gamma	Zoom	X-ctr	Y-ctr	No.	Polygons
203.7	334.6	344.0	1.3686	-4.7245	-8.7738	9784	Ortho

Lockheed Martin Adv. Tech. Center
1410 HRS 31 Jan 01
 S.Barrett..x42088

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FAME : Optics Team

- Robert Barrett   Stray Light Analysis
- Stephanie Barrett   Analysis & PSFs
- Peter Cuneo   Optical Engineering
- Al Hatheway   Consultant
- Tom Muench   Optomechanical Design
- Alice Palmer   Analysis & OTM
- Patrick Perkins   Optical Science
- Paul Robb   Optical Science
- Robert Sigler   Telescope Architectu
- Haig Yengoyan   Mechanical Design & Test

FAME TELESCOPE: Action Items from SRR

- Vignetting: Complete 1/17/01: Moved Compound Mirrors 4
(S. Barrett, P. Dineen)   outboard each, seems to solve the problem

- PSF Case Studies 1-5:   Complete 1/23/01
(S. Barrett)   Also worked cases 6-9

- Prelim. Stray Light Analysis: Complete 2/5/01
(R. Barrett)

- Optics Specifications: Tightened overall optical requirement to 0.025λ
(T. Muench, P.Cuneo) Request for Information (RFI) sent out 2/5/01
         Option for active Secondary Mirror control
         Option for 85% lightweighting
         Option for Silver coating
         Option for integration at optics house
         Replies due 2/21/01

- Active secondary Trade: See following charts
(P. Dineen, S. Barrett)

FAME Defocus Sensitivity
(note: total tolerance is ~0.050λ rms)

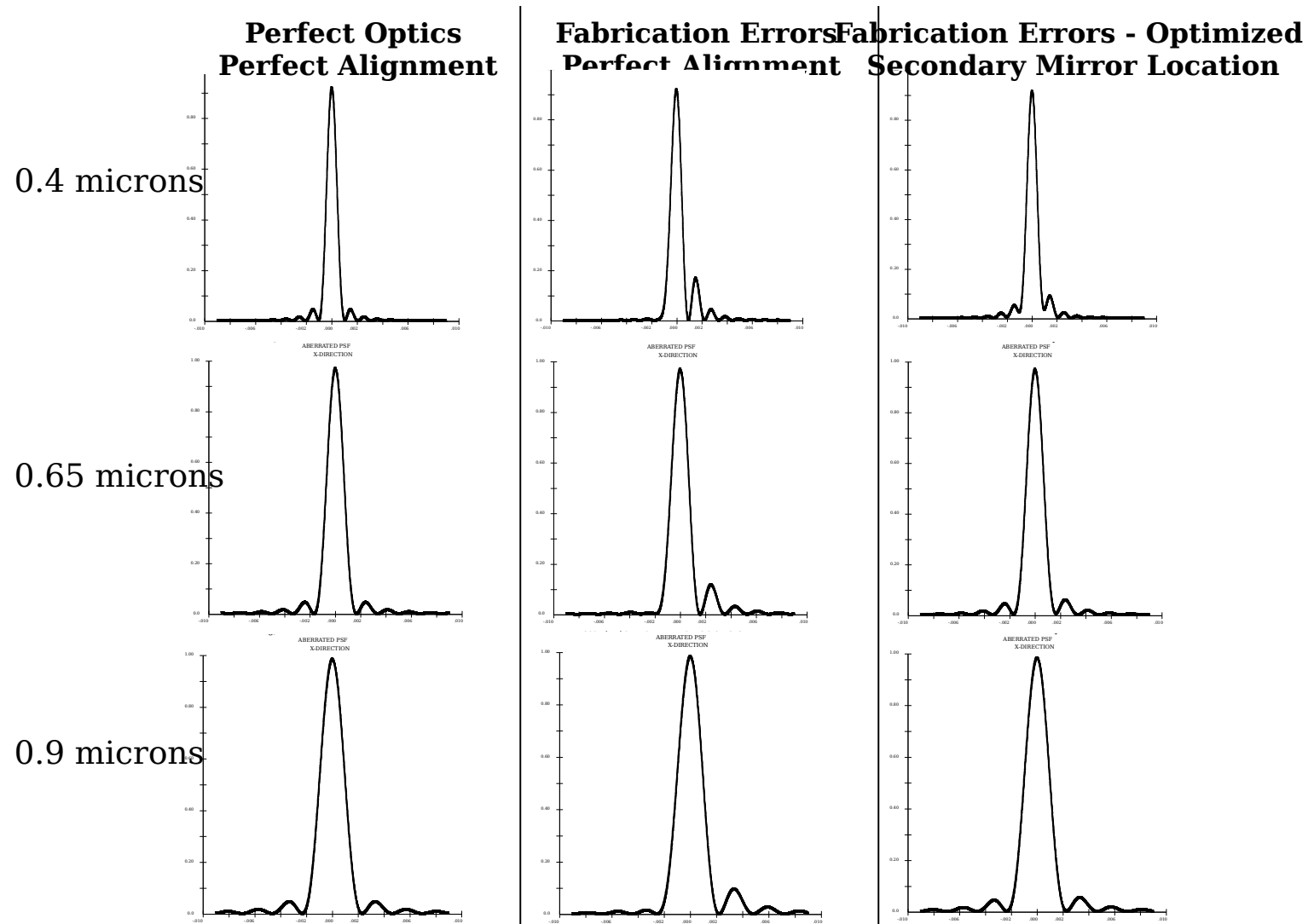|	defocus	microns	RMS wavefront error (wavelength units), 0	RMS wavefront error (wavelength units), 0.4	RMS wavefront error (wavelength units), 0.9	Thickness, 12
Move PM only	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	25	0.356336	0.354964	0.353506	
	with refocus	25	0.002718	0.002595	0.003713	86.975933
Move SM only	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	25	0.406064	0.404632	0.403109	
	with refocus	25	0.002819	0.002665	0.003837	86.903189
Move PM & SM						
	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	25	0.053161	0.051552	0.049813	
	with refocus	25	0.001698	0.000279	0.002013	87.420771

FAME TELESCOPE: Focus Factors
(note: total tolerance is ~1 micron)

- Gravity sag (Primary Mirror)   ~ 50 microns

- CME (moisture loss in composite structure)   ~15 microns

- Variation in CME between struts   ~ 2 microns

- Ambient Temperature effects   ~ 2 microns

- Launch loads   TBD

- Static thermal gradients   TBD

- Long term material stability   TBD

FAME Estimated Fabrication Errors

- We estimated that total wavefront error through the entir
optical train may amount to 0.050λ rms ($= \lambda/4$ PV)
    - $0.044\ \lambda$ rms on Compounds and Aspheres
    - $0.022\ \lambda$ rms on Flats

- Since the exact nature of the aberrations cannot be dedu
a prior, the analysis introduced random errors (randomly
weighted) onto the surface of each Mirror, then scaled
them appropriately

- The resultant PSF became Case (Priority) 2

- USNO reports this degree of error is probably not sufficie
to support 1/350 pixel centroiding

- Some opticians claim they can improve on the overall 0.05

- RFI specifies $0.025\ \lambda$ rms requirement for the entire syste

FAME Estimated Fabrication Errors

	Perfect Optics Perfect Alignment	**Fabrication Errors Perfect Alignment**	**Fabrication Errors - Optimized Secondary Mirror Location**

0.4 microns

0.65 microns

0.9 microns

FAME Tip/Tilt Sensitivity
(note: total tolerance is ~0.050λ rms)

	tilt	About X (arcseconds)	RMS wavefront error (wavelength units), 0	RMS wavefront error (wavelength units), 0.4	RMS wavefront error (wavelength units), 0.9	Thickness, 12
Primary						
	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	8.6	0.059056	0.054312	0.048595	
	with refocus	8.6	0.011538	0.009979	0.010983	87.418491
		About Y (arcseconds)				
	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	8.6	0.046906	0.047327	0.047957	
	with refocus	8.6	0.046819	0.047299	0.047993	87.494085
		About X (arcseconds)				
Secondary						
	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	8.6	0.014719	0.015282	0.015753	
	with refocus	8.6	0.003145	0.003512	0.004069	87.518164
	no refocus	28.8	0.057045	0.055174	0.052584	
	with refocus	28.8	0.011092	0.011265	0.012053	87.575334
		About Y (arcseconds)				
	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	8.6	0.015636	0.016067	0.016901	
	with refocus	8.6	0.015333	0.01595	0.016968	87.493595
	no refocus	28.8	0.050955	0.053198	0.056268	
	with refocus	28.8	0.050871	0.053165	0.056271	87.493626

	decentration	y-axis (microns)	RMS wavefront error (wavelength units), 0	RMS wavefront error (wavelength units), 0.4	RMS wavefront error (wavelength units), 0.9	Thickness, 12
Primary	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	4	0.008541	0.006769	0.004857	
	with refocus	4	0.002135	0.000751	0.001986	87.486602
	no refocus	25	0.035364	0.032623	0.02944	
	with refocus	25	0.006682	0.005649	0.006034	87.449431
	x-axis (microns)					
	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	4	0.005511	0.004717	0.004426	
	with refocus	4	0.004587	0.004315	0.004707	87.493657
	no refocus	25	0.027095	0.02702	0.027049	
	with refocus	25	0.026918	0.026947	0.027088	87.493533

	decentration	y-axis (microns)	RMS wavefront error (wavelength units), 0	RMS wavefront error (wavelength units), 0.4	RMS wavefront error (wavelength units), 0.9	Thickness, 12
Secondar	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	4	0.001467	0.002744	0.004161	
	with refocus	4	0.001422	0.001071	0.002099	87.500128
	no refocus	25	0.026687	0.026324	0.025629	
	with refocus	25	0.005311	0.005685	0.006259	87.533951
	x-axis (microns)					
	nominal	0	0.003447	0.0019	0.000947	87.49639
	no refocus	4	0.005321	0.004474	0.004171	
	with refocus	4	0.004369	0.004063	0.004486	87.493706
	no refocus	25	0.025565	0.025416	0.025392	
	with refocus	25	0.025389	0.025353	0.025453	87.493834

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FAME TELESCOPE: Alternate design options

Some methods to maintain the PM/SM alignment:

• Thermal focus control   Untried, gradients could
affect Basic Angle

• Single block of -
  • Invar   CTE, mass, availability, anisotropic

  • ULE   Mass, availability, fracture risk,
  workability

• Metering rods -

  • Invar   CTE (1 ppm/K) too high

  • ULE/Zerodur   Fracture risk, mass

  • Composite   Same issues as Truss
  Structure

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FAME TELESCOPE: Active Mirror Specificatio

Dynamic range:	± 1 mm
Step size (resolution)	0.2 microns
Actuator	Stepper motors
Number of axes:	3 (Tip, tilt, defocus)
Duty cycle:	Very low
Velocity:	Slow, not critical
Input power:	Low
Thermal output:	Low
Reliability:	High
Encoders/feedback:	Yes
Mass (not including Mirror):	< 4 kg
Stability (power on & off):	0.1 micron